MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

TCV3151 – COMPUTER VISION

(All sections / Groups)

14 OCTOBER 2019
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages with 5 questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

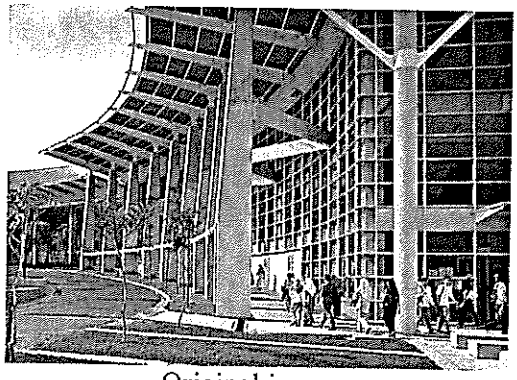
3. Please print all your answers in the answer booklet provided.

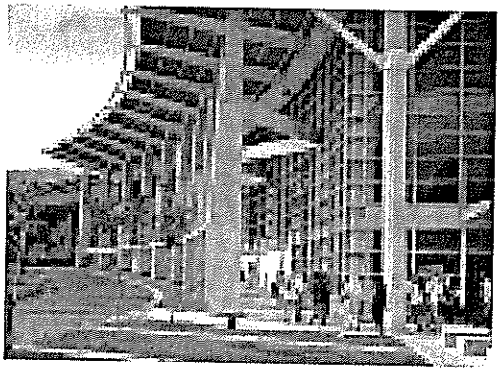
QUESTION 1

(a) Consider an automated food inspection system using computer vision approaches. The system aims to detect location of defects on fresh fruits, e.g. dark contaminants on the fruit surfaces.

(i) What kind of image acquisition device can be used for the automated food inspection system? [1 mark]
(ii) Is pre-processing required for this system? Why? [1 mark]
(iii) Describe the role of segmentation in the automated food inspection system. [1 mark]

(b) Suppose you are working on an image to be uploaded to the university's website. Due to bandwidth limitation, you subsample the images into half of its original size. Following is the effect you observe after sub-sampling the image.


Original image


Sub-sampled image

(i) What effect do you observe in the subsampled image? What causes this effect to happen? [2 marks]
(ii) How can this effect be overcome? [2 marks]

(c) Consider the image segment in Figure 1.1. Let $V = \{1,2\}$, and p refers to the bottom left pixel, while q denotes the top right pixel in the image. Compute the length of the shortest path between p and q using:

(i) 4-path
(ii) 8-path
(iii) m-path

Draw and show the path for each method. If a particular path does not exist between these two points, explain why. [3 marks]

1	1	0	1
2	0	2	1
2	1	0	2
1	0	2	2

Figure 1.1

Continued .....

QUESTION 2

(a) Smoothing and sharpening are two important operations in digital image processing. Describe the difference between smoothing and sharpening operations. [2 marks]

(b) Consider a digital mammogram depicted in Figure 2.1. A point processing operation has been applied on the original image to facilitate the diagnosis process, e.g. detecting the intramammary lymph node shown in Figure 2.2. Explain the point processing operation applied on the original image. Plot the point processing operation. [3 marks]

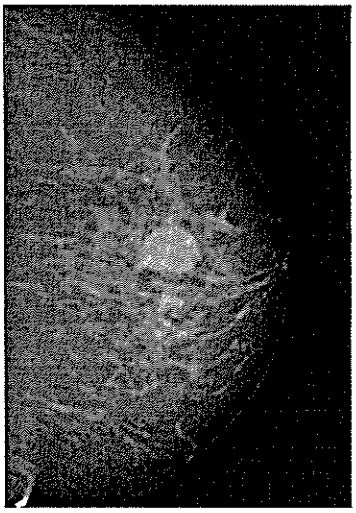


Figure 2.1

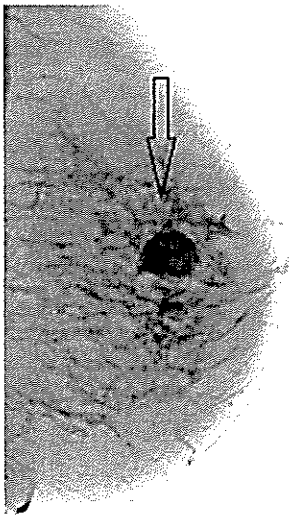


Figure 2.2

(c) Apply histogram equalization on the gray level distribution shown in the table below. Draw the histograms of the original and equalized images.

Gray level	0	1	2	3	4	5	6	7
No. of pixels	64	150	105	86	55	42	80	100

[3 marks]

Continued .....

(d) Suppose you want to detect stationary objects in a scene. For example, given a scene containing a utility knife and a nail in Figure 2.3 and Figure 2.4. You need to identify the utility knife that remains static in the scene as depicted in Figure 2.5 (shown in binary image). How can you achieve such objective? Hint: Arithmetic operation can be applied in this problem. [2 marks]

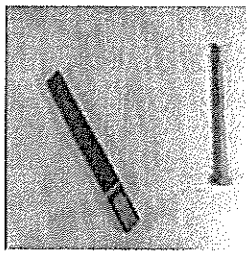


Figure 2.3

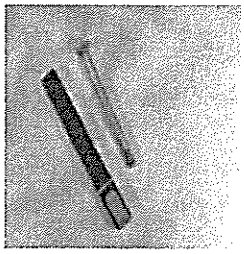


Figure 2.4

Figure 2.5

QUESTION 3

(a) Explain the importance of edge detection in computer vision. [2 marks]

(b) A 3-bit image of size 5-by-5 is shown in Figure 3.1.

x/y	1	2	3	4	5
1	6	5	2	1	3
2	1	2	4	8	0
3	5	7	6	6	3
4	2	1	2	5	2
5	3	0	6	2	8

Figure 3.1

(i) Draw a 3 × 3 mean (average) filter and compute the output of the filter at (3, 3). [2 marks]

(ii) Draw a 3 × 3 Laplacian filter and compute the output of the filter at (3, 3). [2 marks]

Continued .....

(c) Figure 3.2 depicts the image of President Square in Multimedia University. After applying some gradient operators on the image, you obtain the results shown in Figure 3.3 and Figure 3.4.

(i) Name the gradient operators that have been applied on the images. [2 marks]

(ii) Sketch the masks for the gradient operators. [2 marks]

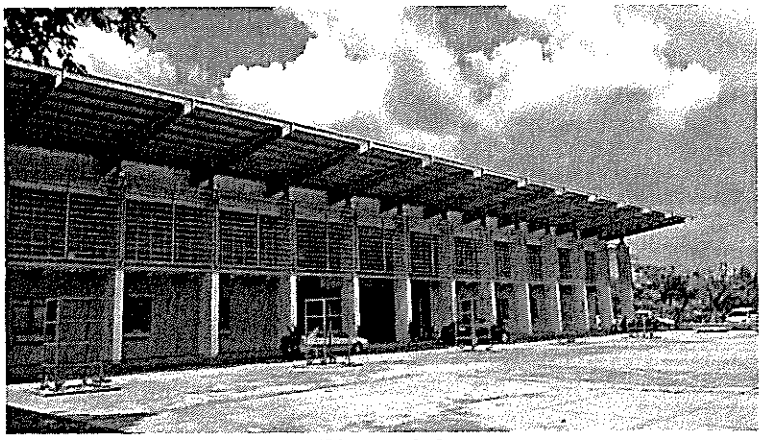


Figure 3.2

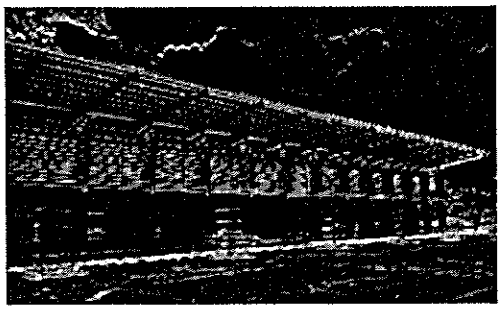


Figure 3.3

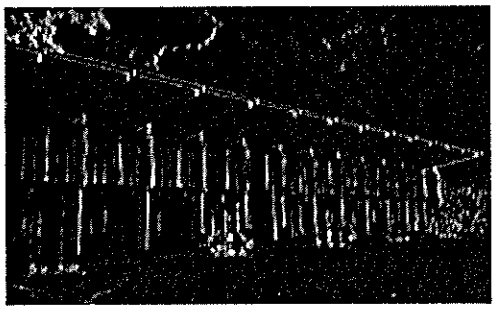


Figure 3.4

Continued .....

QUESTION 4

(a) What is the important criterion for thresholding to work effectively in an object-background separation task? [2 marks]

(b) Matric A is the result of applying run-length encoding on a binary image of size 3×16 pixels as part of a compression process. Recover the original image from A assuming the length of runs approach was used in the compression process. Each row in the original image starts with '1'.

$$A = \begin{bmatrix} 3 & 1 & 4 & 2 & 2 & 1 & 1 & 1 & 1 \\ 0 & 2 & 4 & 1 & 2 & 6 & 0 & 0 & 0 \\ 4 & 5 & 4 & 6 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

[4 marks]

(c) Answer the questions below using the image shown in Figure 4.1.

1	1	1	1
0	0	1	1
0	0	2	2
0	0	3	3

Figure 4.1

(i) Find the normalized co-occurrence matrices for the image using the following offsets:
(1) $d = (1,0)$
(2) $d = (1,1)$

[2 marks]

(ii) Calculate the entropy of the co-occurrence matrices in i(1) and i(2). The formula for entropy is given as $-\sum\sum P[i,j]\, log_2 P[i,j]$.

[2 marks]

QUESTION 5

(a) Distinguish the three approaches used for object recognition: (i) Geometry-based, (ii) Appearance-based, and (iii) Feature-based. [3 marks]

(b) Consider the Figure 5.1 with two features highlighted. Discuss the suitability of using each image feature for tracking. [2 marks]

Continued .....

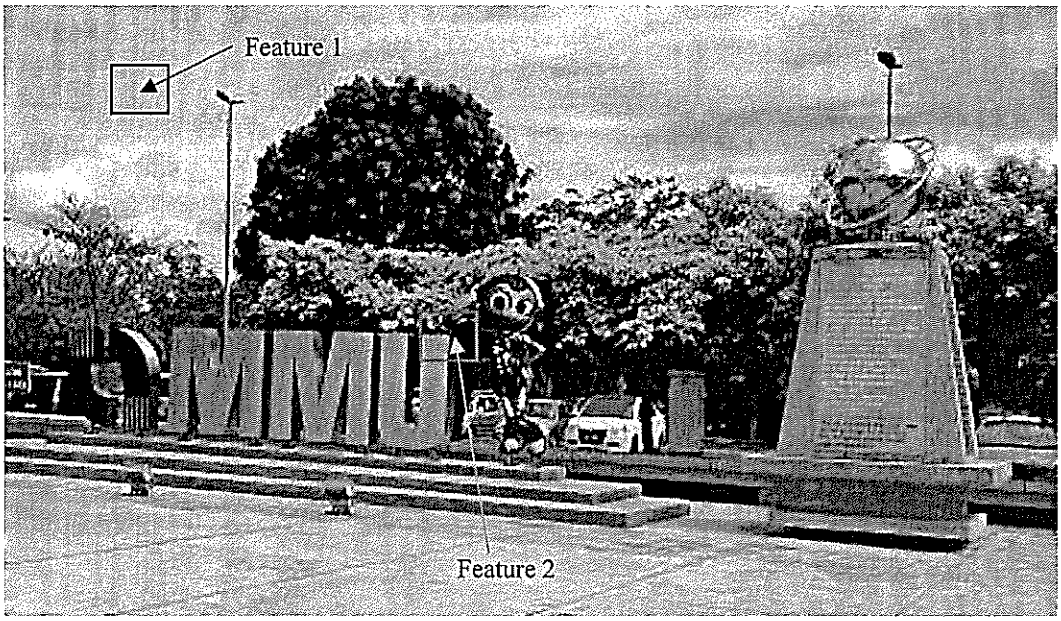


Figure 5.1

(c) Figure 5.2 and Figure 5.3 depict some frames extracted from a video sequence. The first image (Figure 5.2) is considered the reference, the second (Figure 5.3) depicts the same scene some time later. Your objective is to detect the moving person in the scene.

Figure 5.2

Figure 5.3

(i) Explain the method you can use to detect the moving person in the scene. [2 marks]

(ii) Based on the answer in (i), what can you do to reveal the direction of the motion? [2 marks]

(iii) What is the problem associated with the proposed solution in (ii)? [1 mark]

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